COST AND PERFORMANCE REPORT

Pump and Treat of Contaminated Groundwater at the
Old Mill Superfund Site
Rock Creek, Ohio

September 1998

Prepared by:

U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Technology Innovation Office

SITE INFORMATION

Identifying Information

Old Mill Superfund Site
Rock Creek, Ohio

CERCLIS #: OHD980510200

ROD Date: August 7, 1985

Treatment Application

Type of Action: Remedial

Period of operation: September 1989 - Ongoing
(Data collected through 1997)

Quantity of material treated during application: 13 million gallons of groundwater [9]

Background

Historical Activity that Generated Contamination at the Site: Illegal waste disposal

Corresponding SIC Code: NA

Waste Management Practice That Contributed to Contamination: NA

Location: Rock Creek, Ohio

Facility Operations: [4, 11]

- The Old Mill Superfund site includes two parcels of land, the Henfield property and the Kraus property. The Henfield property is approximately three acres in size, and the Kraus property is approximately 10 acres in size (see Figures 1 and 2). The two parcels are located across the road from each other, in a rural setting near the Village of Rock Creek, Ohio. The site was used for illegal disposal of drummed wastes for an undetermined number of years.

- In 1979, the U.S. EPA (EPA) and Ohio EPA (OEPA) found approximately 1,200 drums of waste including oils, resins, and PCBs on the Old Mill site. Drum and soil removal was completed in November 1982 as a Superfund emergency removal activity. The source removal actions at the Old Mill site included removal of drums containing hazardous materials, as well as excavation and off-site disposal of contaminated soil. Allowable Residual Contaminant (ARC) Criteria, or cleanup levels, were calculated to determine the concentrations of contaminants that could remain in the soil. No other contaminant sources, underground or above ground, were identified at the site.

- The site was listed on the National Priorities List (NPL) in September 1983.

- The Remedial Investigation (RI)/Feasibility Study (FS) was completed in 1984. An addendum to the RI was completed in 1985.

Regulatory Context:

- Site activities are conducted under provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, §121, and the National Contingency Plan (NCP), 40 CFR 300 [4].

- On August 7, 1985, the EPA issued a Record of Decision (ROD).

Remedy Selection:

- Extraction of groundwater and treatment via carbon filtration was selected as the remedy for contaminated groundwater at this site. Effluent is discharged to a local waterway. An air stripper and collection trench were added to the remedy during remedial design [4].

SITE INFORMATION (CONT.)

Site Logistics/Contacts

Site Lead: EPA

Remedial Project Manager:
Ron Murawski*
U.S. EPA Region 5
77 W. Jackson Blvd.
Chicago, IL 60604-3590
(312) 886-2940

State Contact:
Mike Eberle
Ohio EPA
216-963-1126

*Indicates primary contacts

Treatment System Vendor:
Aptus Environmental Services, Inc.
Coffeyville, KS 67337
(Construction Contractor)

Operations & Maintenance:
Omprakash Patel (Site Manager)*
Roy F. Weston, Inc.
Suite 400
3 Hawthorn Parkway
Vernon Hills, IL 60061-1450
(847) 918-4051

MATRIX DESCRIPTION

Matrix Identification

Type of Matrix Processed Through the Treatment System: Groundwater

Contaminant Characterization [1,10]

Primary Contaminant Groups: Volatile Organic Compounds (VOCs)

- Contaminants of concern at the site include TCE, PCE, *trans*-1,2-DCE, and VC. Phthalates also were detected at the site. However, since initial sampling, phthalate compounds have not been detected in groundwater.
- Two separate plumes (depicted in Figures 1 and 2) were identified at the site, one on the Kraus parcel and one on the Henfield parcel. The two plumes are not commingled and are located over 1,000 feet apart. As originally detected, the Henfield plume primarily consisted of halogenated VOCs and the Kraus plume consisted of benzene and xylene.
- The maximum contaminant concentrations detected on the Henfield parcel were TCE (6,100 µg/L), PCE (300 µg/L), *trans*-1,2-DCE (460 µg/L), and VC (14 µg/L). The maximum contaminant concentrations detected on the Kraus parcel were ethylbenzene (19,000 µg/L) and xylenes (43,000 µg/L). Halogenated compounds were not originally detected in the plume located on the Kraus parcel. However, during construction activities, TCE and *trans*-1,2-DCE were discovered in the soils and groundwater on the Kraus parcel, and continue to be the primary contaminants within that plume.
- The initial plume at the Henfield parcel extended 150 to 250 feet downgradient from the site. The areal extent of this plume was estimated during the remedial investigation to be 130,000 square feet. Based on a porosity of 30% and plume thickness of five feet, the volume of contaminated groundwater on the Henfield parcel was estimated for this report at 1.5 million gallons. Plume thickness was estimated based on the saturated thickness of the upper aquifer.

MATRIX DESCRIPTION (CONT.)

Contaminant Characterization (Cont.)

- The plume at the Kraus parcel was initially estimated to be 110,000 square feet in areal extent during the remedial investigation. Based on a porosity of 30% and a plume thickness of five feet, the volume of contaminated groundwater at the Kraus parcel was estimated for this report at 1.2 million gallons.
- Figures 1 and 2 depict total VOC contaminant contours for the Old Mill site (as detected during 1984 sampling events). Note the orientation of the figures for later discussion of groundwater characteristics.

Matrix Characteristics Affecting Treatment Costs or Performance

Hydrogeology: [1, 3, 10]

Two distinct hydrogeologic units have been identified beneath this site. Groundwater moves across the site at a relatively slow rate of 20 feet per year. The first hydrogeologic characterization depicted the site as primarily two interconnected soil groups. However, later findings during characterization efforts in 1985 showed that the site was actually two separate aquifers with an aquitard in between.

Groundwater is found at approximately five feet below ground surface. The majority of the groundwater contamination is found in the upper unit. Groundwater flow is to the west-southwest on the Henfield property and to the north-northwest on the Kraus property. Rock Creek is located approximately 500 feet south of the site. Tables 1 and 2 include technical aquifer information and well data, respectively.

Unit 1	Glacial till	The upper unit is approximately 10 feet thick and consists of silty glacial till. The aquifer is considered poor quality for domestic well supply. This unit is separated from the underlying shale unit by a low conductivity layer of a clayey till that acts as an effective aquitard. The clayey till is approximately five feet thick.
Unit 2	Weathered Shale	This lower unit is approximately 16 feet thick and consists of a weathered shale with evident vertical fractures. The porosity of this unit decreases with depth.

Table 1. Technical Aquifer Information

Unit Name	Thickness (ft)	Conductivity (ft/day)	Average Velocity (ft/day)	Flow Direction
Glacial Till (Henfield)	10	1.25	0.055	West-Southwest
Weathered Shale (Henfield)	16	0.22	NA	West
Glacial Till (Kraus)	10	1.25	0.055	North-Northwest
Weathered Shale (Kraus)	16	0.22	NA	North-Northwest

Source: [10]
NA - not available

MATRIX DESCRIPTION (CONT.)

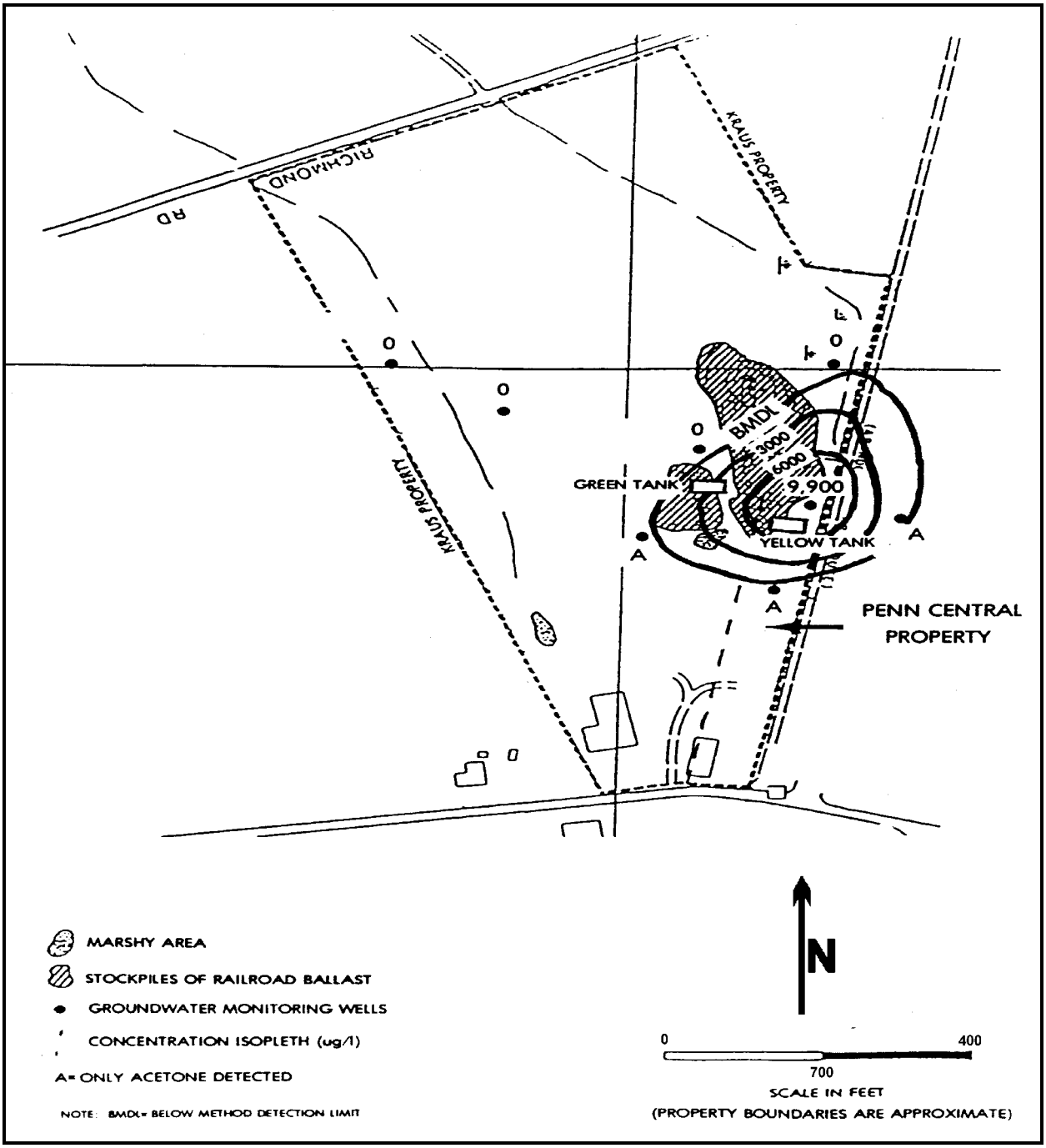

Figure 1. Total VOC Concentration Contour Map of the Kraus Property (1984) [1]

MATRIX DESCRIPTION (CONT.)

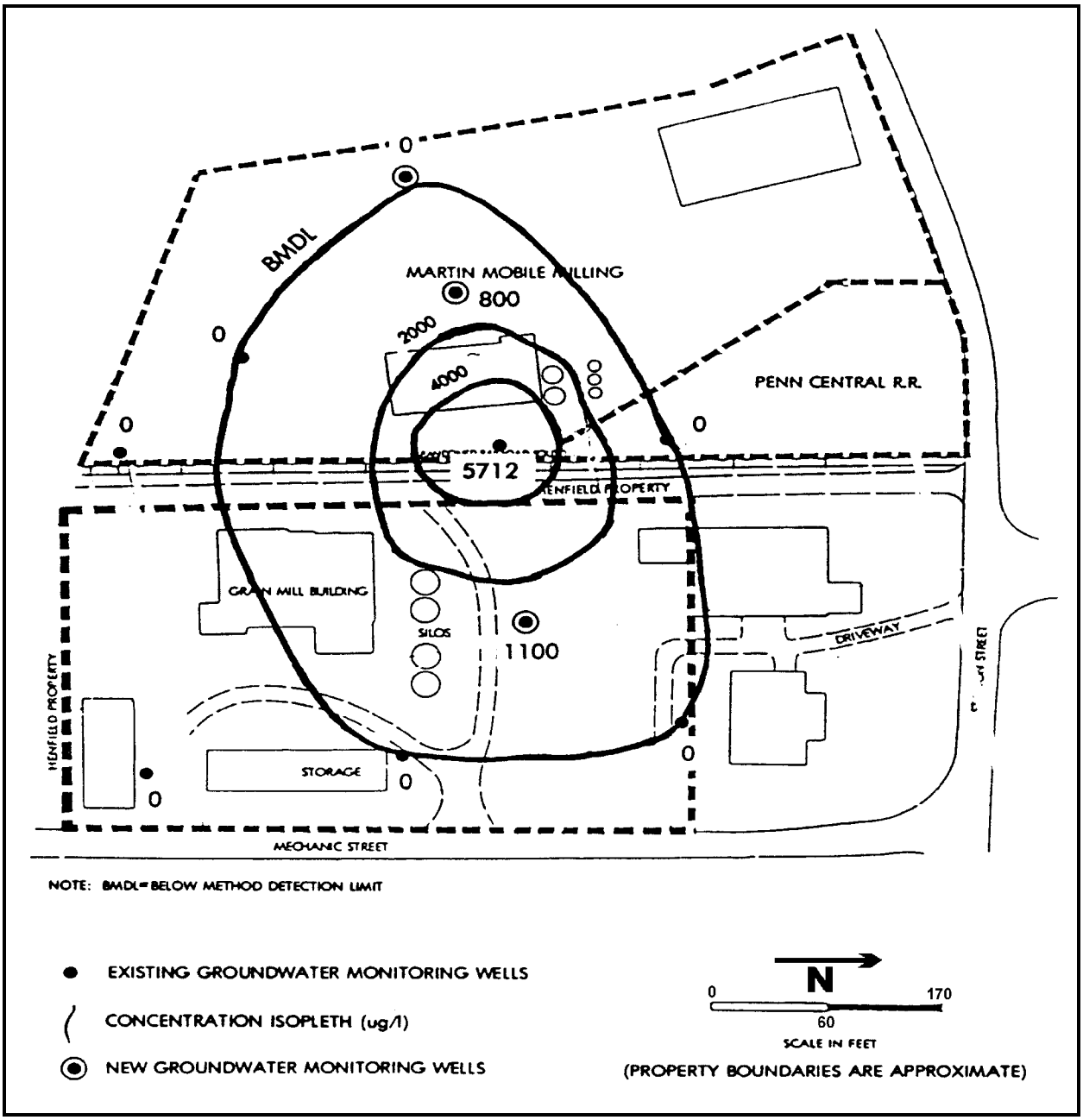

Figure 2. Total VOC Concentration Contour Map of the Henfield Property (1984) [1]

TREATMENT SYSTEM DESCRIPTION

Primary Treatment Technology

Pump and treat (P&T) with air stripping

Supplemental Treatment Technology

Carbon adsorption, particulate filters

System Description and Operation

Table 2. Technical Well Data

Extraction Well Name	Unit Name	Depth (ft)	Design Yield (gpd)
Martin Sump*	Glacial Till	7	1,000
Henfield Sump	Glacial Till	7	1,175
Kraus Sump-1	Glacial Till	7	1,000
Kraus Mod-2	Glacial Till	7	900
Kraus A-Sump	Glacial till	7	140
Henfield Well	Lower Aquifer	25	700
Kraus Well-1	Lower Aquifer	25	215
Kraus Well-2	Lower Aquifer	25	100

*The Martin Sump is located off site adjacent to the Henfield property in the downgradient part of the plume.
Source: [3]

System Description [3]

- The P&T system has been designed to remediate plumes from both parcels. The current extraction system for both plumes consists of three deep recovery wells to extract groundwater from the lower unit (lower aquifer) and five collection trenches to collect groundwater from the upper unit (glacial till). The collection trenches are seven feet deep and total 1,055 feet in linear length. The deep recovery wells are approximately 25 feet deep with a 10-foot screen interval set at the bottom. The extraction system was designed to remove a total of five gpm from the aquifer. The deep recovery wells were placed in the center of the plumes and the collection trenches at the toe of the plumes. Extracted water from both plumes is treated in one treatment plant.

- The part of the extraction system on the Kraus property required several modifications. The original extraction system consisted of two deep extraction wells and one collection trench. During construction, a new area of VOC-contaminated groundwater was discovered. Construction temporarily stopped while a revised design was configured. Once approved by EPA, a second collection trench was constructed approximately 200 feet downgradient of the first. This collection trench is 73 feet long and was placed to capture the newly detected groundwater contaminants.

- In 1993, the plume of TCE and 1,2-DCE on the Kraus property was observed downgradient of the second collection trench. As a result, a third collection trench was constructed on the Kraus property, and placed approximately 250 feet downgradient of the second trench. It is over 360 feet long and is situated to completely intercept the migrating plume. Two new monitoring wells were added to monitor groundwater downgradient of the third collection trench.

- During design of the treatment plant, a recycle line was incorporated to boost process flow from 5 gpm to 35 gpm through the stripping tower. This change allowed for more efficient blower sizing and stripping media selection.

- The initial, on-site treatment system consists of an 18-inch diameter air-stripping tower and two 1,000-pound granular

TREATMENT SYSTEM DESCRIPTION (CONT.)

System Description and Operation (Cont.)

activated carbon adsorption units in series. In March, 1997, the two carbon units were replaced by one 1,000-pound, granular activated carbon unit. Polypropylene saddle-type packing media are used in the stripping tower with a packing height of 14 feet.

- A groundwater monitoring system consisting of 18 wells on the Kraus property (including the two new wells), eight wells on the Henfield property, and eight total piezometers on both properties is used to track contaminant movement and groundwater flow.

- Effluent from the treatment system is discharged to Rock Creek under a NPDES permit. Rock Creek is located 500 feet south of the site.

System Operation [5-9,11]

- Quantity of groundwater pumped from aquifer by year:

	Volume Pumped (gal)	
Year	**Upper Unit**	**Lower Unit**
1990	1,377,424	495,777
1991	1,793,060	404,081
1992	1,186,225	269,540
1993	1,756,546	294,605
1994	1,235,491	327,780
1995	1,019,864	274,777
1996	1,455,491	277,132
1997	1,849,201	407,829

- The extraction network continues to extract groundwater from both the deep and shallow aquifers at a 20:80 ratio. Overall, groundwater extraction rates declined slightly during the first seven years of operation, then increased by 30 percent in the eighth year.

- The treatment train includes carbon filtration to remove any organic compounds, such as phthalates, that may remain in the effluent from the air stripper. The operating history of the treatment plant indicates that very little, if any, material enters the carbon treatment unit. As reported in each Annual Performance Report, the activated carbon may be under-utilized. A new carbon adsorption tank was installed in March 1997, replacing two existing tanks. No other carbon changes have occurred during the life of the system.

- The extraction network on both properties has worked well with no reported clogging problems. Pumps within wet wells associated with the collection trenches have reportedly worked properly.

- From March 1990 to September 1997, the system was 99% operational.

- Air stripper media has not required changing during this period of operation.

- Following the replacement of the old carbon units with a new carbon unit, the groundwater extraction rate increased significantly.

TREATMENT SYSTEM DESCRIPTION (CONT.)

Operating Parameters Affecting Treatment Cost or Performance

The major operating parameter affecting cost or performance for this technology is the extraction rate. Table 3 presents the value measured for this and other performance parameters.

Table 3. Performance Parameters

Parameter	Value	
Extraction Rate	Avg. = 3.1 gpm (2.46 - 4.18)	
Performance Standard (Effluent NPDES Limits)	PCE TCE TCA *trans*-1,2-DCE	4.1 µg/L 1.9 µg/L 3.8 µg/L 1.6 µg/L
Remedial Goals (Aquifer)	PCE TCE 1,2-DCE ethylbenzene	8.2 µg/L 15.0 µg/L 1.9 µg/L 8,000 µg/L
Note: The average system extraction rate was 4,500 gpd based on 13 million gallons of groundwater pumped and a 99% operation rate.		

Source: [3]

Timeline

Table 4 presents a timeline for this application.

Table 4. Timeline

Start Date	End Date	Activity
8/85	---	ROD signed
2/87	---	Changes made to the remedial design
6/87	6/89	Extraction and collection system constructed, and contaminated soils removed
3/89	6/89	Additional collection trench and deep extraction well added to Kraus collection system based on field sampling conditions during soils removal operations
9/89	---	Treatment system operations begun
4/94	7/94	Additional collection trench and monitoring wells added to the Kraus property

TREATMENT SYSTEM PERFORMANCE

Cleanup Goals/Standards

Specific cleanup criteria were established during the design phase by OEPA and EPA personnel. Table 3 includes goals for contaminants of concern. These goals must be met throughout the aquifer as measured in all on-site wells [4].

Additional Information on Goals

The cleanup goals for groundwater remediation at this site were based on achieving a 1×10^{-5} carcinogenic risk level [4].

TREATMENT SYSTEM PERFORMANCE (CONT.)

Treatment Performance Goals [3]

- To contain the contaminant plume and prevent off-site migration of contaminants.
- To reduce effluent contaminant concentrations to meet NPDES permit requirements.

Performance Data Assessment [5-13]

- The 1997 annual sampling data indicate that the P&T system has contained the plume; however, contaminant concentrations in much of the plume remain above established goals. Although additional collection trenches were required at the Kraus property, no contaminants have migrated off site. [9]
- After eight years of operation, levels of TCE and *trans*-1,2-DCE still exceed cleanup goals. Figures 3 and 4 show concentrations of TCE and 1,2-DCE in on-site sampling points on the Henfield Property. Figures 5 and 6 depict TCE and 1,2-DCE concentrations detected on the Kraus property. Concentrations in Figure 6 are an average of two wells in the deep aquifer.
- The 1993 annual performance report indicated that the plume of contaminants in the shallow aquifer had migrated past the second collection trench. As a result, an additional collection trench was added and appears to be providing adequate containment. No contaminants have migrated off site.
- The Henfield plume has been contained with the original collection trench and deep extraction well configuration. No contaminants have migrated downgradient of the Henfield site.
- Two hot spots in the vicinity of the Henfield sump and Kraus modified sump remain problematic at this site. As of March 1997, TCE concentrations in the Kraus modified sump and the Henfield sump were 1,400 µg/L and 1,700 µg/L, respectively.
- The maximum concentrations of contaminants in the groundwater during the July 1997 sampling event were TCE (1,700 µg/L), *trans*-1,2-DCE (730 µg/L), and PCE (93 µg/L).
- Figure 7 presents the removal of total contaminants through the treatment system from 1990 to 1997. The P&T system removed approximately 124 pounds of contaminant mass during this period.
- Due to increased concentrations of TCE and 1,1-DCE in the influent and increased flow through the treatment plant, the VOC mass loading to the treatment plant has increased in 1997.
- Groundwater level contour maps in annual reports indicate the deep extraction wells are creating an inward gradient over the affected areas. The collection trenches are also creating an inward gradient in their vicinity. Groundwater that naturally flows toward the trenches is collected.
- As noted earlier, the second goal of the treatment system is to remove contaminants from extracted groundwater to meet discharge requirements of the NPDES permit. Based on annual performance reports, discharge requirements have been met consistently. Phthalate compounds, which may require carbon treatment, have not been detected in influent or effluent sampling.
- Total contaminant removal rates reported in annual performance reports have fluctuated; however, the trend of the contaminant removal rate has declined exponentially from 0.08 lbs/day in July 1991 to 0.01 lbs/day in September 1996. However, the contaminant removal rate increased to 0.04 lbs/day in 1997.

TREATMENT SYSTEM PERFORMANCE (CONT.)

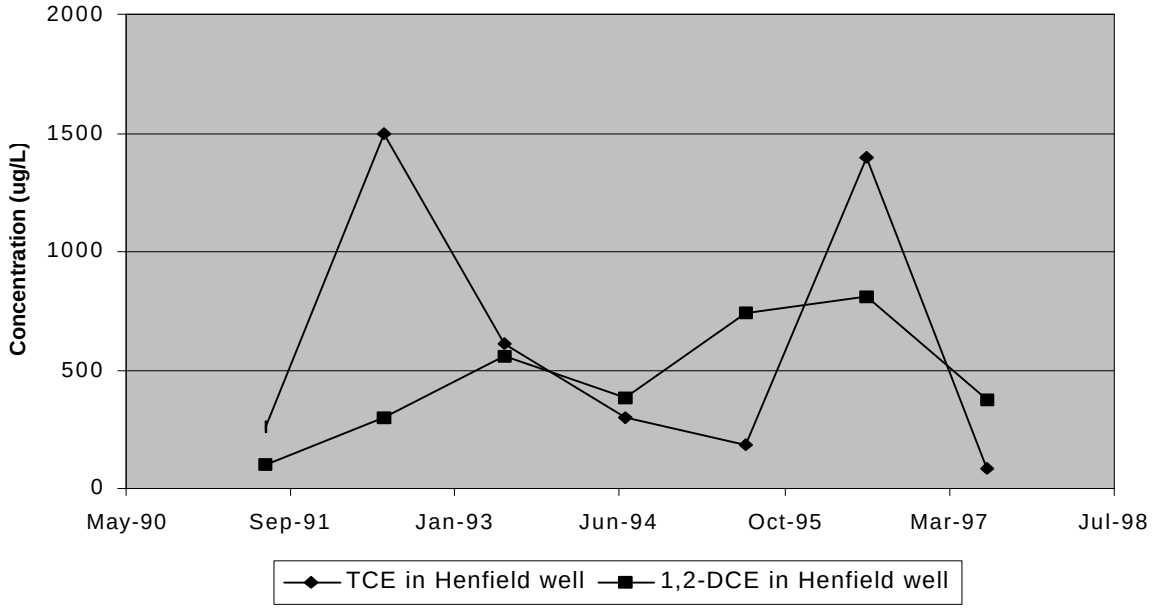

Figure 3. TCE and 1,2-DCE Concentrations on the Henfield Property (Deep Aquifer) (July 1991 - October 1996) [6-9,12]

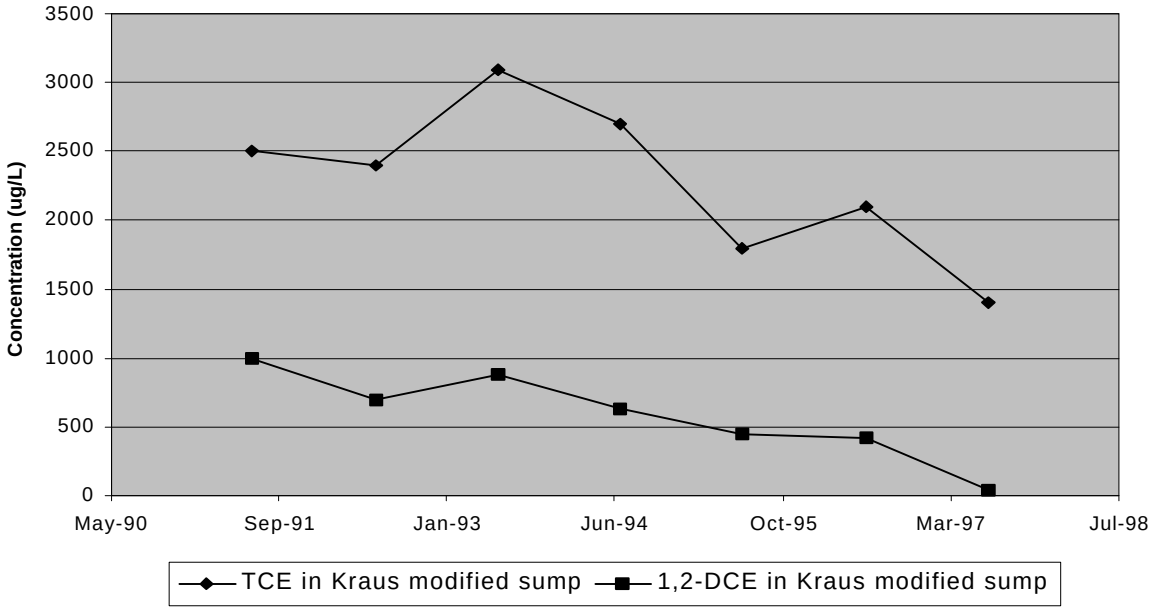

Figure 4. TCE and 1,2-DCE Concentrations on the Kraus Property (Shallow Aquifer) (July 1991 - July 1997) [6-9,12]

TREATMENT SYSTEM PERFORMANCE (CONT.)

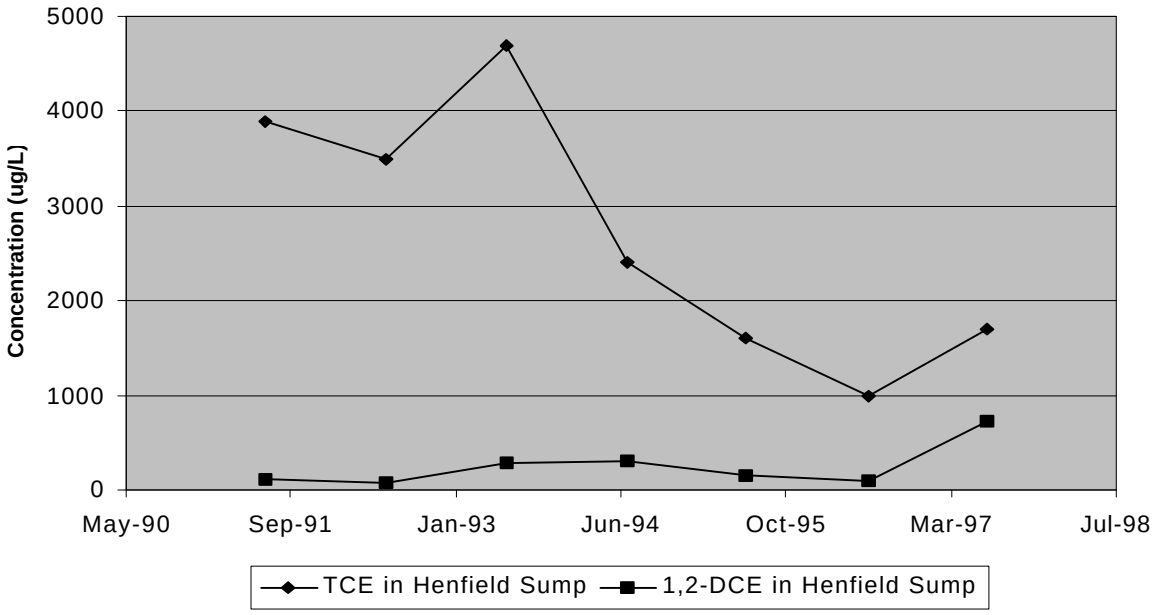

Figure 5. TCE and 1,2-DCE Concentrations on the Henfield Property (Shallow Aquifer) (July 1991 - July 1997) [6-9,12]

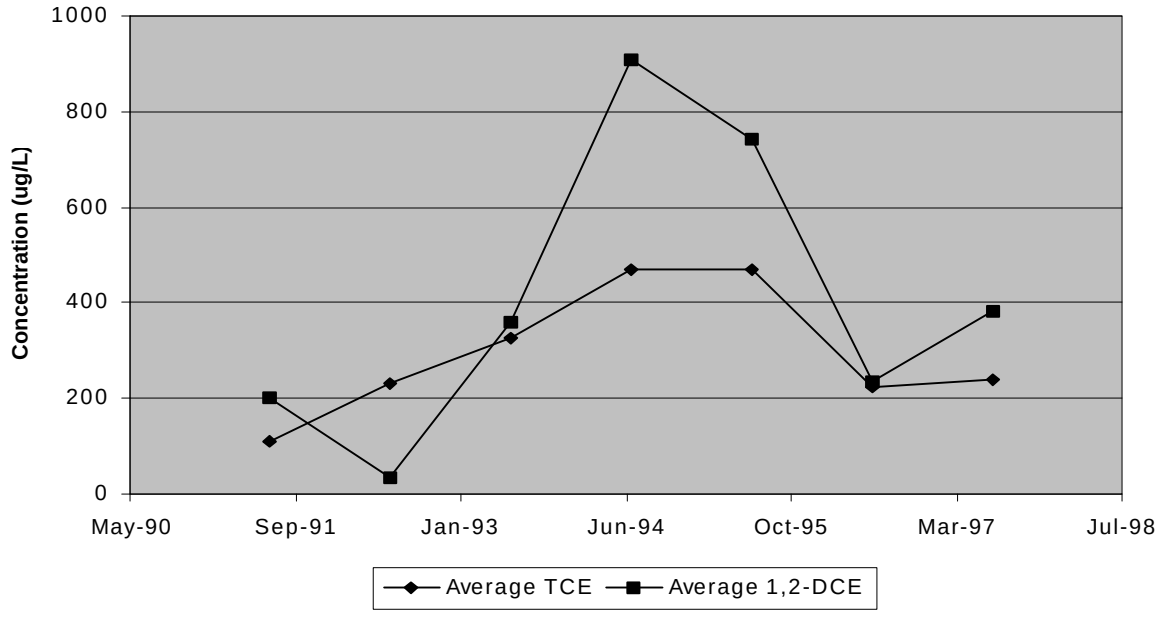

Figure 6. TCE and 1,2-DCE Concentrations on the Kraus Property (Deep Aquifer) (July 1991 - July 1997) [6-9,12]

TREATMENT SYSTEM PERFORMANCE (CONT.)

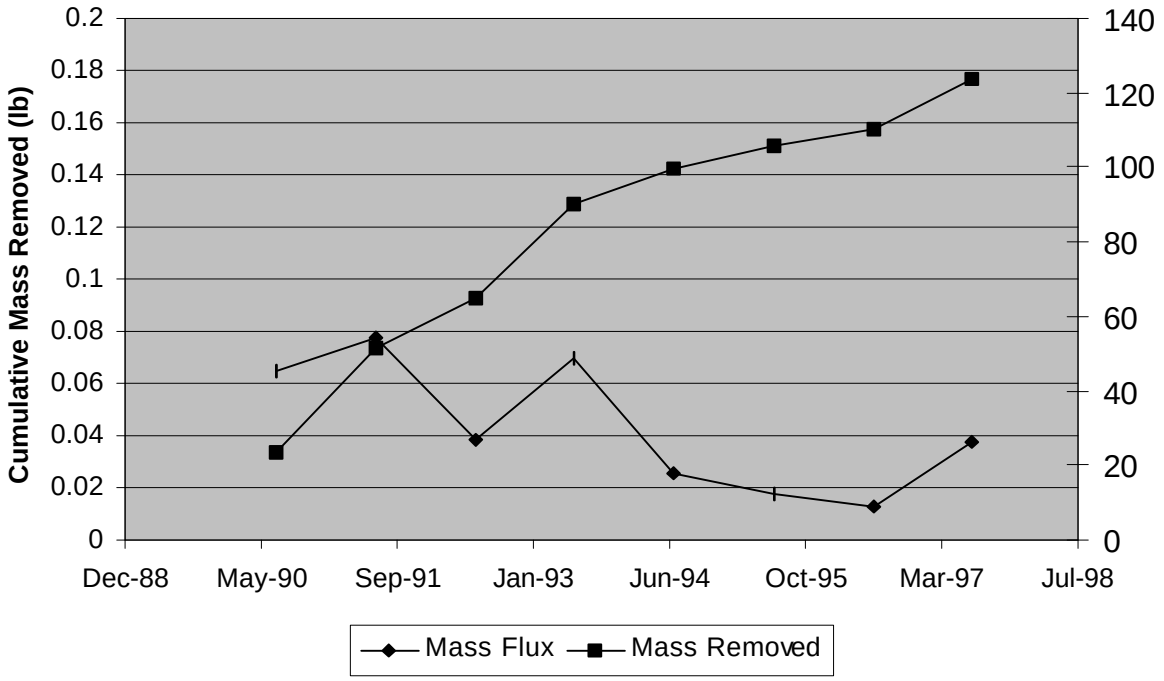

Figure 7. Mass Flux Rate and Cumulative Mass (TCE, 1,2-DCE, and PCE) Removal (1990 - 1997) [6-9,12]

Performance Data Completeness

- Performance data for influent, effluent, and groundwater concentrations are available quarterly from 1990.
- Contaminant mass removal and the volume of groundwater treated annually was provided in annual performance reports.
- Contaminant concentrations detected during annual sampling events were used for analyses performed in this report. References 6 through 9 and 14 contain annual sampling data.
- When results were reported below detection limits, half of the detection limit was used for evaluation purposes.

Performance Data Quality

The QA/QC program used throughout the remedial action met the EPA and the State of Ohio requirements. All monitoring was performed using EPA-approved methods, and the vendor did not note any exceptions to the QA/QC protocols.

TREATMENT SYSTEM COST

Procurement Process

The U.S. Army Corps of Engineers (USACE) was responsible for oversight during construction activities. Woodward-Clyde was awarded the remedial design contract. The USACE contracted with Aptus Environmental to perform remedial action activities. Roy F. Weston is the operations and maintenance contractor for the treatment facility.

Cost Analysis

All costs for the investigation were borne by the U.S. EPA and OEPA. The U.S. EPA is responsible for O&M costs for the first 10 years, at which point the State of Ohio will assume responsibility.

Capital Costs [2]

Remedial Construction	
Monitoring Wells, Sampling	$138,000
Backfilling and Paving	$474,000
Groundwater Extraction System	$537,200
Groundwater Treatment Facility	$345,100
Additional collection trench, monitoring wells (1994)	$101,700
Total Remedial Construction	**$1,596,000**

Operating Costs [2]

Cumulative Operating Costs (1989-1996)	
Labor	$787,132
Utilities	$93,230
Analytical	$478,308
Maintenance	$22,568
Miscellaneous	$34,215
Report Preparation	$224,547
Total Operating Expenses	**$1,640,000**

Other Costs

Remedial Design	$954,235
Corps Oversight	$49,968

Cost Data Quality

Actual capital and operating cost data were provided by the U.S. EPA Remedial Project Manager (RPM), including a detailed breakdown of the cumulative operating costs included in this report.

OBSERVATIONS AND LESSONS LEARNED

- Collection trenches were added to improve plume containment. This modification resulted in an increase of $286,000 to total capital costs. $184,000 of this increase was included in the original remedial action costs; $102,000 was added in 1994.
- The total cost of treatment using the P&T system was $3,236,000, consisting of $1,596,000 in capital costs and $1,640,000 in cumulative operating costs through 1997. This corresponds to a cost of $26,100 per pound of contaminant removed and $250 per thousand gallons of groundwater treated.
- The actual capital cost for this project was approximately $286,000 more than the original bid cost. An additional $184,000 was required during initial construction activities and $102,000 was added in 1994. This represents a 22% increase in capital costs over the original bid cost.
- The average annual O&M cost, based on the first eight years of operation, was approximately $205,000 per year. This cost includes O&M costs, report preparation costs, analytical costs, and capital expenditure costs [13].
- After eight years of P&T operation and the removal of 124 pounds of contaminants

OBSERVATIONS AND LESSONS LEARNED (CONT.)

from the groundwater, the cleanup goals have not been met.

- In several wells, concentrations of contaminants have increased above initial levels. According to the RPM formerly assigned to the site, the reason for the increase in groundwater concentration is not known at this time; however, it potentially is due to precipitation increase or a subsurface source zone [2].

- According to the RPM, the P&T system at this site does not appear to have the typical effect on groundwater contamination. New contaminants have been identified after the initial investigation and contaminant concentrations have increased at times during operations. The reasons for these events is not known at this time [2].

- A dual-stage carbon adsorption system was built into the treatment system to handle the anticipated levels of semivolatiles in the influent; however, the levels in the influent stream have not been above detection limits since operations began. Consequently, the activated carbon units have not been utilized as intended and may not have been necessary [11].

REFERENCES

1. Remedial Investigation Report for Old Mill, CH2M Hill, 1984.
2. Correspondence with Remedial Project Manager. U.S. EPA Region V, May 7, 1997.
3. Remedial Action Report, U.S. Army Corps of Engineers, 1990.
4. Superfund Record of Decision, U.S. EPA, 1985.
5. Eighth Quarterly Evaluation Report, Roy F. Weston, Inc., 1993.
6. Third Annual Performance Evaluation Report, Roy F. Weston, Inc., 1993.
7. Fourth Annual Performance Evaluation Report, Roy F. Weston, Inc., 1994.
8. Fifth Annual Performance Evaluation Report, Roy F. Weston, Inc., 1995.
9. Sixth Annual Performance Evaluation Report, Roy F. Weston, Inc., 1996.
10. Addendum to the Remedial Investigation Report, CH2M Hill, 1985.
11. Five Year Review, U.S. EPA, 1996.
12. Seventh Annual Performance Evaluation Report, Roy F. Weston, Inc., April 1998
13. Comments on the April 14, 1998 Preliminary Draft Cost and Performance Report, Ron Murawski and Omprakash Patel, May 18, 1998.

Analysis Preparation

This case study was prepared for the U.S. Environmental Protection Agency's Office of Solid Waste and Emergency Response, Technology Innovation Office. Assistance was provided by Eastern Research Group, Inc. and Tetra Tech EM Inc. under EPA Contract No. 68-W4-0004.

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